RC J1148+0455 IDENTIFICATION: GRAVITATIONAL LENS OR GROUP OF GALAXIES ?

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Abstract

The structure of the radio source RC B1146+052 of the "Cold" catalogue is investigated by data of the MIT–GB–VLA survey at 4850 MHz. This source belongs to the steep spectrum radio sources subsample of the RC catalogue. Its spectral index is α = -1.04. The optical image of this source obtained with 6m telescope is analysed. The possible explanations of the complex structure of radio components are considered.

1 Introduction

Using RATAN–600 "Cold" catalog (Parijskij et al., 1996), we have selected steep spectrum sources having two-component structure of the FRII type (Fanaroff and Riley, 1974). Among the "Cold" catalog we have mapped with VLA about 100 such objects. The majority of these objects is identified with elliptical galaxies up to 24–25^m R (Kopylov et al., 1995; Parijskij et al., 1998), which were observed with the 6m telescope of the Special astrophysical observatory by the program "Big Trio".

To understand a structure of the object we have used VLA observations from the MIT–GB survey (Bennet et al., 1986), which crosses the "Cold" survey region. The detailed maps have been obtained for 69 objects of RC catalog using MIT–GB–VLA data (Fletcher, 1996).

In this paper we study a nature of the radio source RC B1146+052 (RC J1148+0455) of the "Cold" catalog using radio maps obtained in the MIT–GB–VLA survey showing a complex structure of components and 6m telescope data.

There were several explanations of the complex structure of radio components. One of them describes the Eastern components as a possible candidate to the gravitational lens (Fletcher, 1998). We have studied this problems in details.

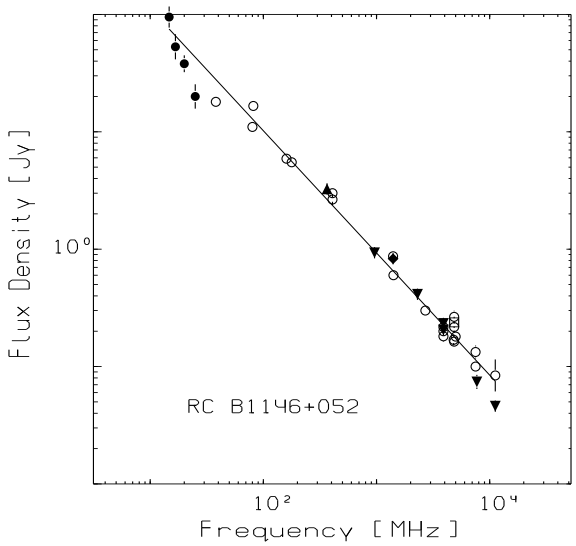

Figure 1: Spectrum of radio source RC B1146+052 including UTR data (Braude et al., 1979), 4C data (Pilkington & Scott, 1965: object 4C+05.53) and Parks data (Otrupcek & Wright, 1991). Spectrum has been prepared using data of the CATS database.

Table 1: Positions and flux densities at 4850 MHz of components of RC B1146+052, by the MIT-GB-VLA survey data

radio component	$\alpha + \delta(B1950.0)$	$\alpha + \delta(J2000.0)$	S_{peak} mJy/beam	S_{int} mJy
A	114612.38+051214.8	114846.48+045534.2	28.4	166
B	114615.07+051158.6	114849.16+045517.9		96
B2	114615.03+051158.4	114849.12+045517.8	5.7	
B1	114615.06+051158.9	114849.16+045518.3	4.3	
B3	114615.10+051158.3	114849.19+045517.7	6.2	
A+B data	114613.37+051207.6	114847.46+045527.0		263

2 Radio data

Using the CATS database (Verkhodanov et al., 1998) we have prepared a radio spectrum of the source. The spectral index α obtained with linear fitting by the least square method equals to –1.04 ($S \sim \nu^{\alpha}$). This allows us to classify this object as the ultra steep spectrum source.

To study a radio structure of RC B1146+052 we have used the VLA survey data archived in the Massachusetts Institute of Technology. A resolution of the image is $0''.5$ at 4850 MHz in A-configuration.

The component A (Fig.3 and 4) has a curved structure and been classified earlier (Lawrence et al., 1986; Parijskij et al., 1996) as a double independent radio source. The component B has a complex structure with 3 maxima. If this component is a separate source and taking into account its complex structure it is possible to consider it a candidate to the gravitational lensed source (Fletcher, 1998). The coordinates of the both component maxima at 4850 MHz are given in Table 1. The distance between components is $43''$.

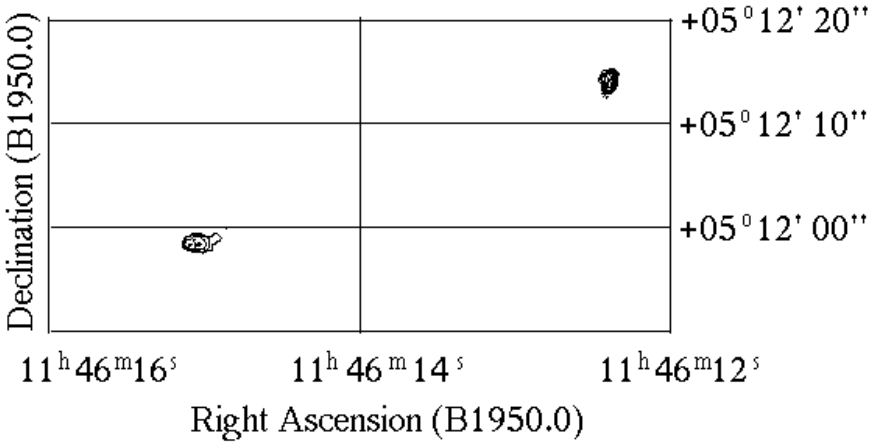

Figure 2: Two component structure of the object RC B1146+052. A component (Western) is on the right, a component B (Eastern) is on the left

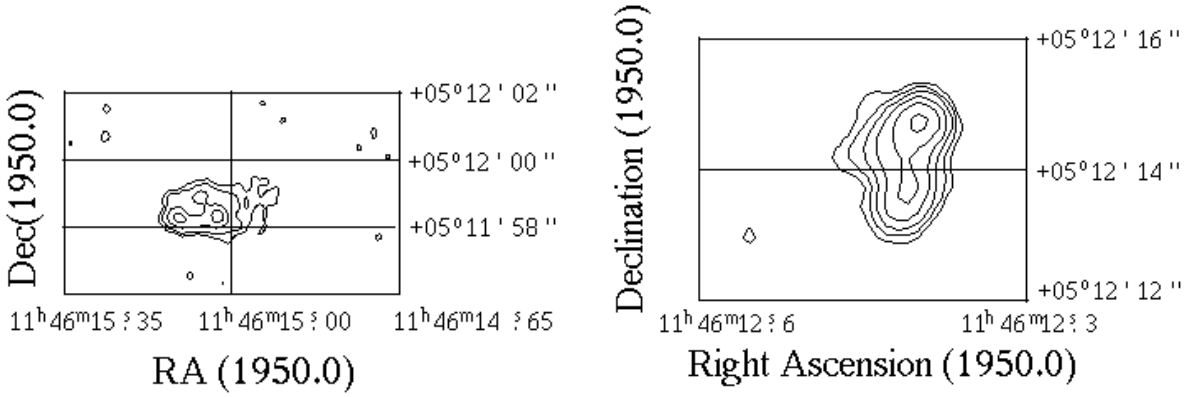

Figure 3: A components structure (from right to left: A and B) of RC B1146+052.

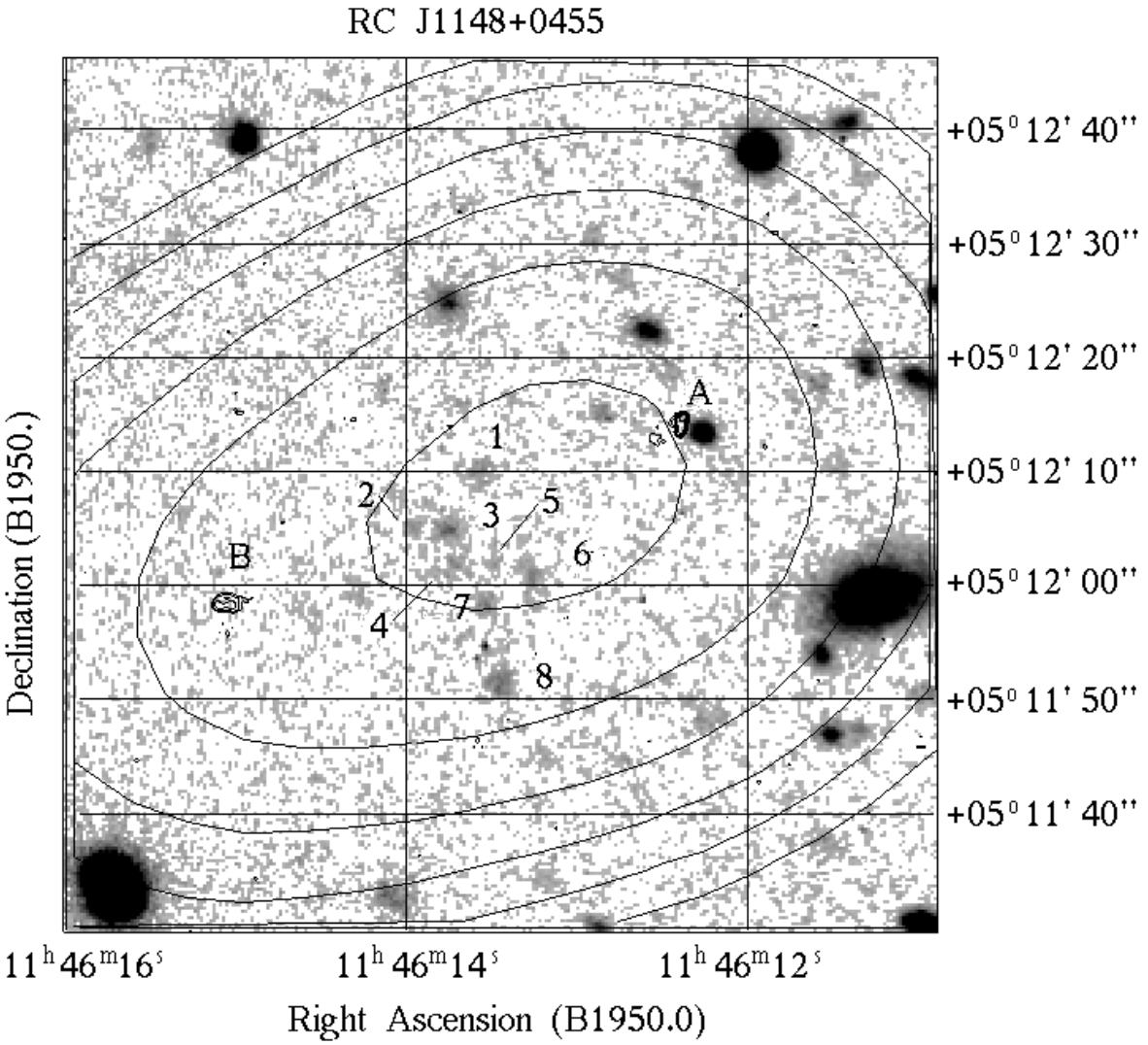

Figure 4: MIT–GB–VLA survey contours (A and B) of RC B1146+052 at 4885 MHz (from the level of 1 mJy with factor 2) and NVSS contours at 1400 MHz (from the level of 80 mJy with factor 2) overlaid on the 6m telescope R–image.

3 Optical identification

In Fig.4 are plotted contours of the radio source RC B1146+052 by the MIT–GB–VLA survey and NVSS survey overlaid on the 6m telescope image in R–filter.

A group of 8 galaxies lies near the center of the NVSS source. The brightness one of them lies on an axis connecting both components. It has a magnitude of $23^m.2 \pm 0^m.2$ in the R–filter within an aperture of 3". Some characteristics of this group galaxies are given in Table 3.

4 Discussion

Using all the data discussed above we conclude that the radio source RC B1146+052 can not be a result of two blending objects, but it has a type of FRII. In this case, the parent galaxy, apparently, belongs to the group of galaxies. The curved form of the A component can be explained as a result of interaction with the gaseous environment, and a form of the B

Table 2: Coordinates and magnitude of galaxies in the group

Number	$\alpha(B1950.0)$	$\delta(B1950.0)$	R-mag
1	11 46 13.58	+5 12 10.2	23.8
2	11 46 13.96	+5 12 05.3	24.3
3	11 46 13.77	+5 12 04.9	23.2
4	11 46 13.73	+5 12 01.9	23.7
5	11 46 13.48	+5 12 01.9	24.4
6	11 46 13.27	+5 12 00.1	23.7
7	11 46 13.55	+5 11 58.3	23.6
8	11 46 13.45	+5 11 51.7	23.1

component can be explained in the frames of the jet rotation hypothesis or also as a result of interaction with the gaseous environment as in Cygnus A.

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References

[1] C.Bennett, B.Burke, J.Hewitt, C.Lawrence, J.Mahoney. Astrophys. J. Suppl. Ser., **61**, p.1, 1986.

[2] S.Ia.Braude, A.V.Megn, K.P.Sokolov, N.K.Sharykin. Astrophys. J. Suppl. Ser., **64**, p.127, 1979.

[3] J.J.Condon, W.D.Cotton, E.W.Greisen, Q.F.Yin, R.A.Perley, J.J.Broderick. Astron. J., **115**, p.1693, 1998.

[4] B.L.Fanaroff, J.M.Riley. MNRAS, **167**, p.31, 1974.

[5] A.Fletcher, S.Conner, F.Crawford, J.Cartright, B.Berke, Yu.N.Parijskij, N.S.Soboleva, A.I.Kopylov, A.V.Temirova, O.V.Verkhodanov, M.N.Naugolnaya. Astron. Zh. **73**, p.835, 1996.

[6] A.Fletcher. Ph.D. thesis. Massachusetts Inst. of Tech. Boston. USA. 1998.

[7] P.C.Gregory, J.J.Condon. Astrophys. J. Suppl., **75**, p.1011, 1991.

[8] P.C.Gregory, W.K.Scott, K.Douglas, J.J.Condon. Astrophys. J. Suppl. Ser., **103**, p.427, 1996.

[9] A.I.Kopylov, V.M.Goss, Yu.N.Parijskij, N.S.Soboleva, A.V.Temirova, O.P.Zhelenkova, Val.V.Vitkovskij, M.N.Naugolnaya, O.V.Verkhodanov. Astron. Zh. **72**, p.613, 1995.

[10] C.W.Lawrence, C.L.Bennett, J.N.Hewitt, G.I.Langston, S.E.Klotz,, B.F.Burke. , Astrophys. J. Suppl. Ser., **61**, p.105, 1986.

[11] R.E.Otrupcek, A.E.Wright. Proc. Astron. Soc. of Australia, **9:1**, 170 (PKSCAT90), 1991.

[12] Yu.N.Parijskij, N.N.Bursov, N.M.Lipovka, N.S.Soboleva, A.V.Temirova. Astron. Astrophys. Suppl. Ser., **87**, p.1, 1991.

[13] Yu.N.Parijskij, N.N.Bursov, N.M.Lipovka, N.S.Soboleva, A.V.Temirova, A.V.Chepurnov. Astron. Astrophys. Suppl. Ser., **96**, p.583, 1992.

[14] Yu.N.Parijskij, W.M.Goss, A.I.Kopylov, N.S.Soboleva, A.V.Temirova, O.V.Verkhodanov, O.P.Zhelenkova, M.N.Naugolnaya. Bull. SAO, No **40**, p.5, 1996.

[15] Yu.N.Pariskij, V.M.Goss, A.I.Kopylov, N.S.Soboleva, A.V.Temirova, O.V.Verkhodanov, O.P.Zhelenkova. Astron. Zh., **75**, p.483, 1998.

[16] J.D.H.Pilkington, P.F.Scott. Mem. Roy. Astron. Soc. **69**, p.183, 1965.

[17] O.V.Verkhodanov, S.A.Trushkin, H.Andernach, V.N.Chernenkov. In "Astronomical Data Analysis Software and Systems VI", eds. G.Hunt & H.E.Payne. ASP Conference Series, Vol.**125**, P.322, 1997.

[18] O.Verkhodanov, H.Andernach, N.V.Verkhodanova, N.Loiseau. In Proc. "Observational Cosmology with the New Radio Surveys", eds. M.Bremer, N.Jackson & I.P'erez-Fournon, Kluwer Acad. Publ., **226**, p.255, 1998.